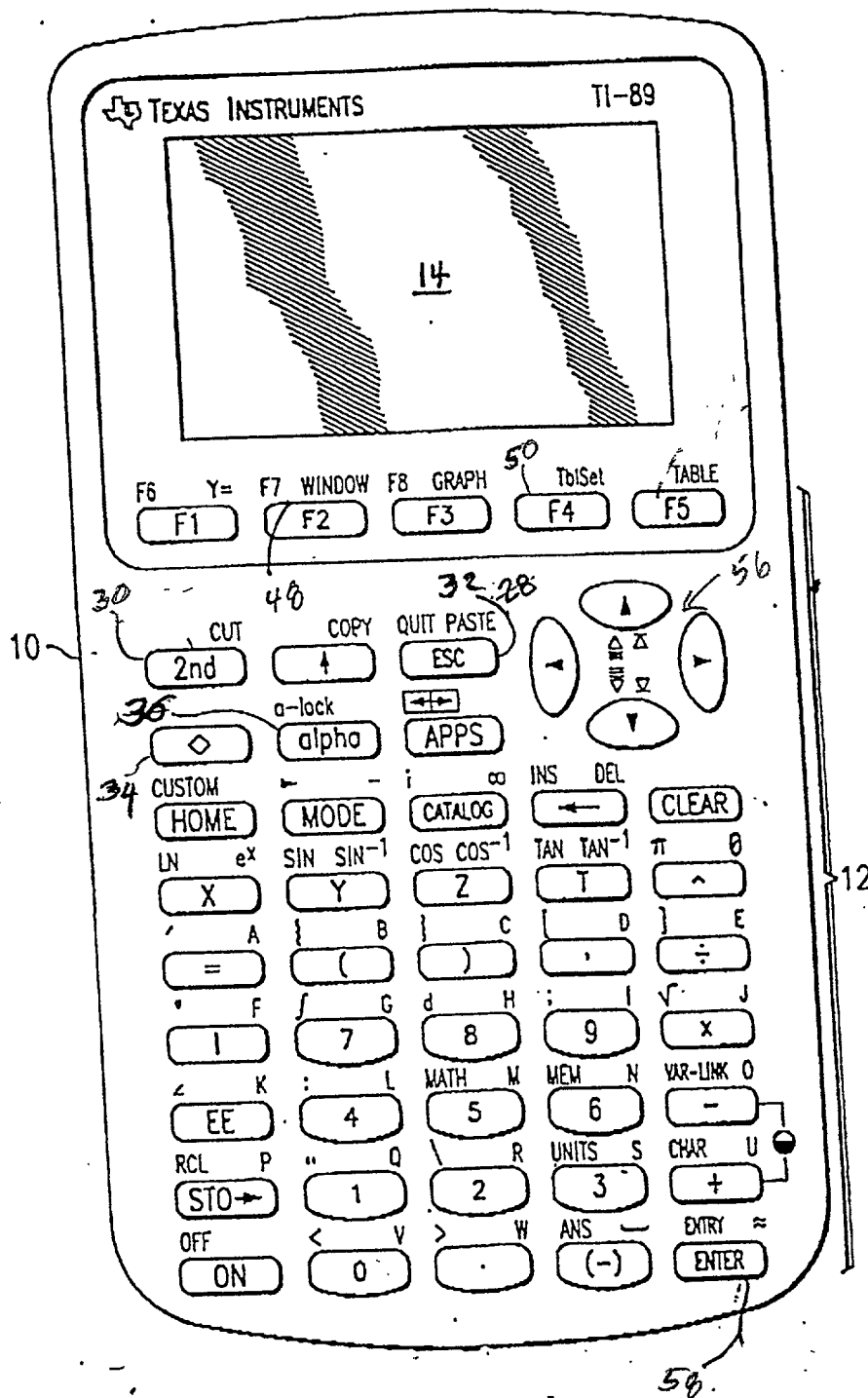


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FIG. 1A



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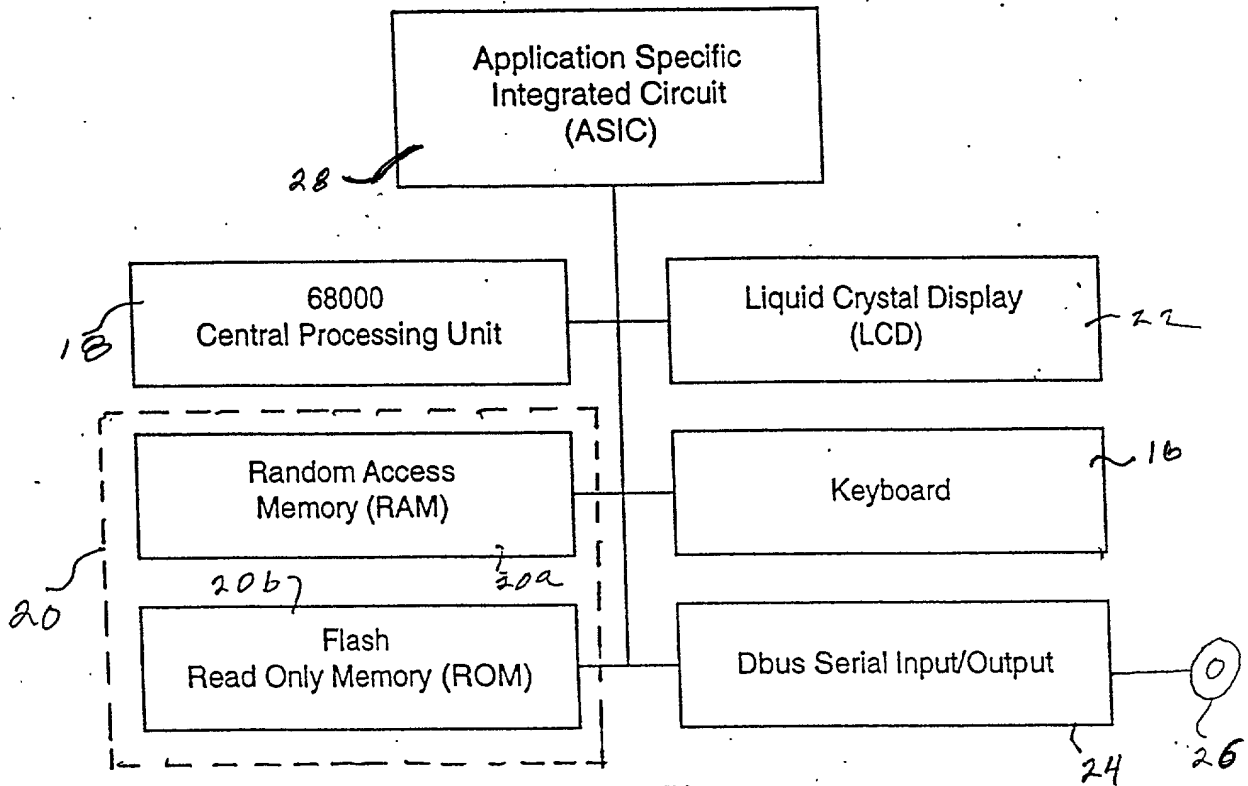
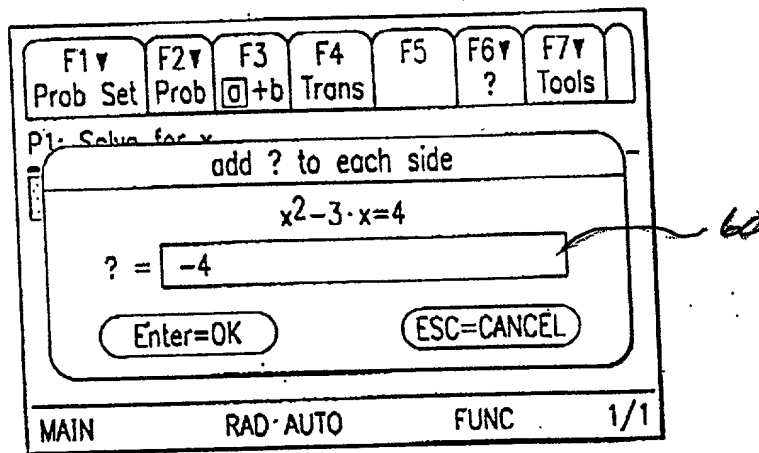
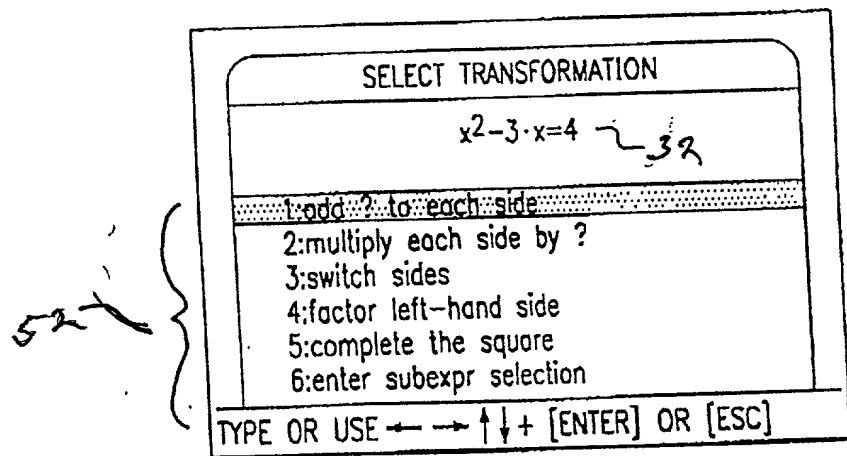
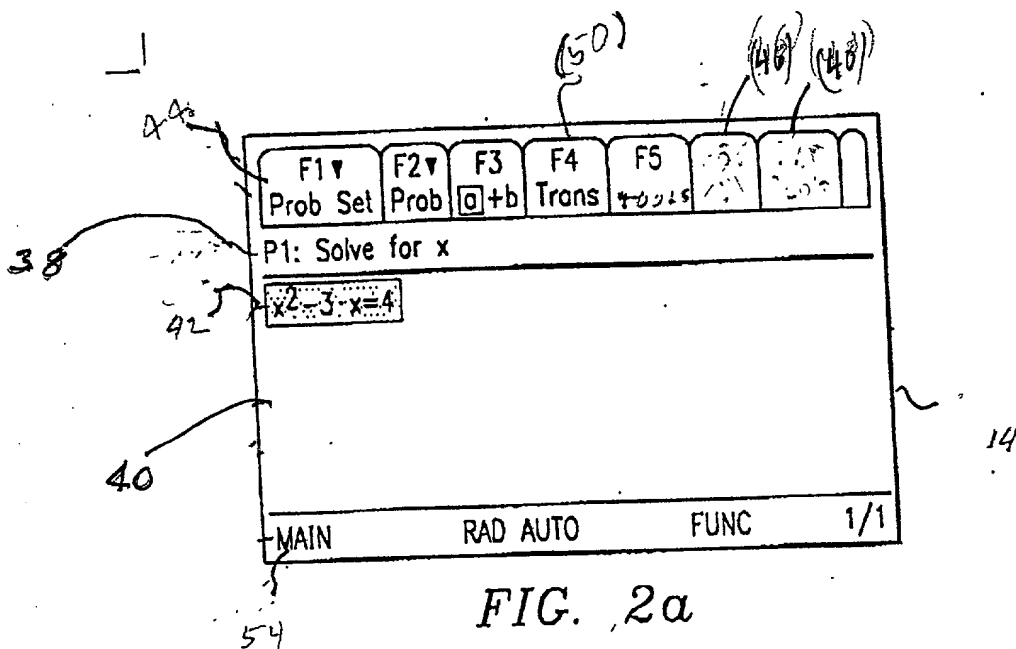


FIG 1B



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F1▼ Prob Set	F2▼ Prob	F3 [a]+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-------------	-------------	----	----------	--------------

P1: Solve for x

$x^2 - 3 \cdot x = 4$

► add -4 to each side

Press <ENTER>

MAIN	RAD AUTO	FUNC	PAUSE
------	----------	------	-------

FIG. 2d

F1▼ Prob Set	F2▼ Prob	F3 [a]+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-------------	-------------	----	----------	--------------

P1: Solve for x

$x^2 - 3 \cdot x = 4$

► add -4 to each side

$x^2 - 3 \cdot x + -4 = 4 + -4$

MAIN	RAD AUTO	FUNC	1/1
------	----------	------	-----

FIG. 2e

F1▼ Prob Set	F2▼ Prob	F3 [a]+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-------------	-------------	----	----------	--------------

P1: Solve for x

$x^2 - 3 \cdot x = 4$

► add -4 to each side

$x^2 - 3 \cdot x + -4 = 4 + -4$

► simplify

Press <ENTER>

MAIN	RAD AUTO	FUNC	PAUSE
------	----------	------	-------

FIG. 2f

F1▼ Prob Set	F2▼ Prob	F3 [a]+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-------------	-------------	----	----------	--------------

P1: Solve for x

$x^2 - 3 \cdot x = 4$
 ► add -4 to each side
 $x^2 - 3 \cdot x + -4 = 4 + -4$
 ► simplify
 $x^2 - 3 \cdot x - 4 = 0$

MAIN RAD AUTO FUNC 1/1

FIG. 2g

SELECT TRANSFORMATION			
$x^2 - 3 \cdot x - 4 = 0$			
1: add ? to each side			
2: multiply each side by ?			
3: switch sides			
4: factor left-hand side			
5: quadratic formula			
6: enter subexpr selection			
MAIN	RAD AUTO	FUNC	1/1

FIG. 2h

F1▼ Prob Set	F2▼ Prob	F3 [a]+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-------------	-------------	----	----------	--------------

P1: Solve for x

$x^2 - 3 \cdot x + -4 = 4 + -4$
 ► simplify
 $x^2 - 3 \cdot x - 4 = 0$
 ► factor left-hand side
 $(x-4) \cdot (x+1) = 0$

MAIN RAD AUTO FUNC 1/1

FIG. 2i

SELECT TRANSFORMATION			
$(x-4) \cdot (x+1) = 0$			
1: add ? to each side			
2: multiply each side by ?			
3: switch sides			
4: $A \cdot B = 0 \rightarrow A = 0$ or $B = 0$			
5: distribute multiplication			
6: $(A \pm B) \cdot C \rightarrow A \cdot C \pm B \cdot C$			
7: $A \cdot (B \pm C) \rightarrow A \cdot B \pm A \cdot C$			
MAIN	RAD AUTO	FUNC	1/1

FIG. 2j

F1▼	F2▼	F3	F4	F5	F6▼	F7▼	
Prob Set	Prob	$\boxed{a} + b$	Trans		?	Tools	
P1: Solve for x							
$x^2 - 3 \cdot x - 4 = 0$							
► factor left-hand side							
$(x-4) \cdot (x+1) = 0$							
► $A \cdot B = 0 \rightarrow A = 0$ or $B = 0$							
$x-4=0$ or $x+1=0$							
MAIN		RAD AUTO		FUNC		1/1	

FIG. 2k

SELECT TRANSFORMATION	
$x-4=0$ or $x+1=0$	
1: solve linear equation	
2: enter subexpr selection	
TYPE OR USE ← → ↑ ↓ + [ENTER] OR [ESC]	

FIG. 2l

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F1▼ Prob Set	F2▼ Prob	F3 □+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-----------	-------------	----	----------	--------------

P1: Solve for x

$(x-4) \cdot (x+1) = 0$

► $A \cdot B = 0 \rightarrow A=0$ or $B=0$

$x-4=0$ or $x+1=0$

► solve linear equation

$x=4$ or $x=-1$

MAIN	RAD AUTO	FUNC	1/1
------	----------	------	-----

FIG. 2m

F1▼ Prob Set	F2▼ Prob	F3 □+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-----------	-------------	----	----------	--------------

P1: Solve for x

$x^2 - 3 \cdot x - 4 = 0$

► quadratic formula

$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4 \cdot 1 \cdot -4}}{2 \cdot 1}$ or ►

MAIN	RAD AUTO	FUNC	1/1
------	----------	------	-----

FIG. 2n

F1▼ Prob Set	F2▼ Prob	F3 □+b	F4 Trans	F5	F6▼ ?	F7▼ Tools
-----------------	-------------	-----------	-------------	----	----------	--------------

P1: Solve for x

► quadratic formula

$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4 \cdot 1 \cdot -4}}{2 \cdot 1}$ or ►

► simplify

$x=4$ or $x=-1$

MAIN	RAD AUTO	FUNC	1/1
------	----------	------	-----

FIG. 2o

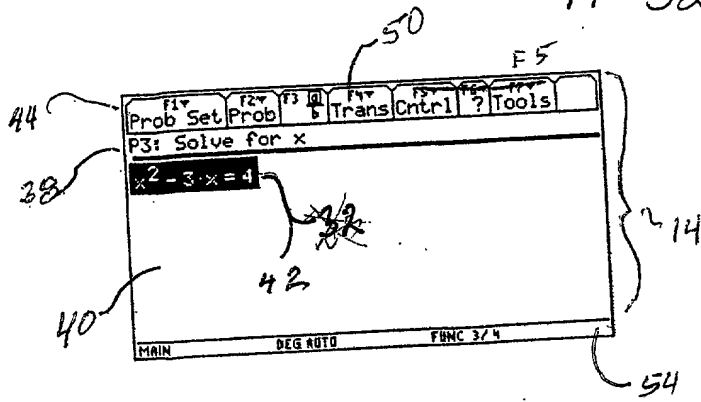


FIG 3a

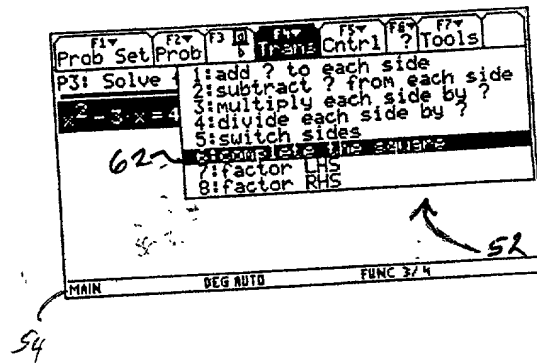


FIG 3b

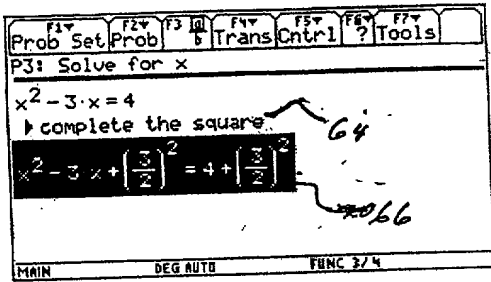


FIG 3c

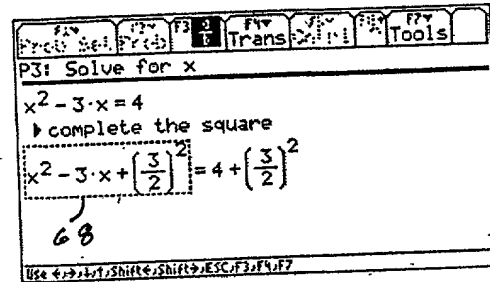


FIG 3d

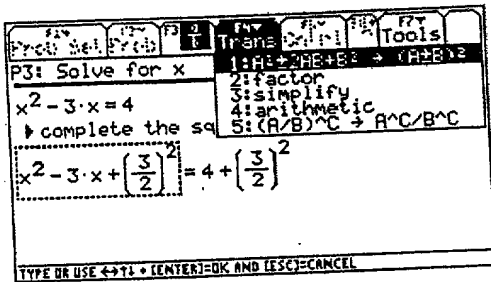


FIG 3e

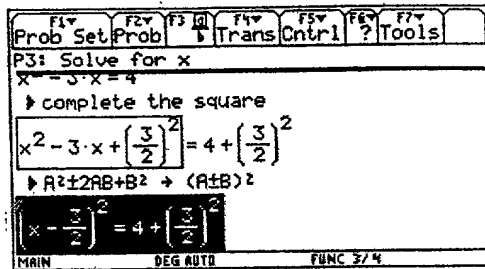


FIG 3f

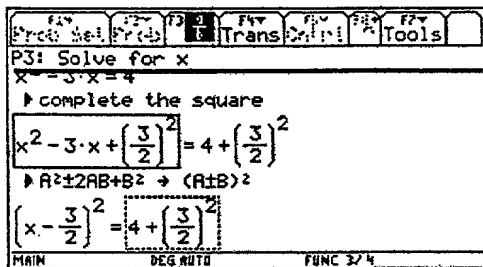


FIG 3g

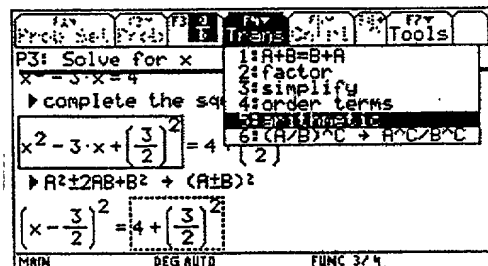


FIG 3h

F1V	F2V	F3	F4V	F5V	F6V	F7V
Prob	Set	Prob	Trans	Cntrl	?	Tools

P3: Solve for x

$$A^2 \pm 2AB + B^2 \rightarrow (A \pm B)^2$$

$$\left(x - \frac{3}{2}\right)^2 = 4 + \left(\frac{3}{2}\right)^2$$

arithmetic

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

MAIN DEG AUTO FUNC 3/4

FIG 3i

F1V	F2V	F3	F4V	F5V	F6V	F7V
Prob	Set	Prob	Trans	Cntrl	?	Tools

P3: Solve for x

- 1: add ? to each side
- 2: subtract ? from each side
- 3: multiply each side by ?
- 4: divide each side by ?
- 5: switch sides
- 6: $A^2 \pm 2AB + B^2 \rightarrow A \pm B$ or $A = -B$
- 7: expand
- 8: $(A \pm B)^2 \rightarrow A^2 \pm 2AB + B^2$

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

arithmetic

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

MAIN DEG AUTO FUNC 3/4

FIG 3j

F1V	F2V	F3	F4V	F5V	F6V	F7V
Prob	Set	Prob	Trans	Cntrl	?	Tools

P3: Solve for x

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

arithmetic

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

$A^2 = B \rightarrow A = \sqrt{B}$ or $A = -\sqrt{B}$

$$x - \frac{3}{2} = \sqrt{\frac{25}{4}} \text{ or } x - \frac{3}{2} = -\sqrt{\frac{25}{4}}$$

MAIN DEG AUTO FUNC 3/4

FIG 3k

F1V	F2V	F3	F4V	F5V	F6V	F7V
Prob	Set	Prob	Trans	Cntrl	?	Tools

P3: Solve for x

- 1: solve linear equation
- 2: $A(A) + A(1/2)$
- 3: distribute
- 4: $A(A/B) + A(A)/A(B)$
- 5: $A(A/B) + A(A)/A(B)$
- 6: evaluate

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

arithmetic

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

$A^2 = B \rightarrow A = \sqrt{B}$ or $A = -\sqrt{B}$

$$x - \frac{3}{2} = \sqrt{\frac{25}{4}} \text{ or } x - \frac{3}{2} = -\sqrt{\frac{25}{4}}$$

MAIN DEG AUTO FUNC 3/4

FIG 3L

F1V	F2V	F3	F4V	F5V	F6V	F7V
Prob	Set	Prob	Trans	Cntrl	?	Tools

P3: Solve for x

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

$A^2 = B \rightarrow A = \sqrt{B}$ or $A = -\sqrt{B}$

$$x - \frac{3}{2} = \sqrt{\frac{25}{4}} \text{ or } x - \frac{3}{2} = -\sqrt{\frac{25}{4}}$$

evaluate

$$x - \frac{3}{2} = \frac{5}{2} \text{ or } x - \frac{3}{2} = -\frac{5}{2}$$

MAIN DEG AUTO FUNC 3/4

FIG 3M

F1V	F2V	F3	F4V	F5V	F6V	F7V
Prob	Set	Prob	Trans	Cntrl	?	Tools

P3: Solve for x

- 1: solve linear equation

$$\left(x - \frac{3}{2}\right)^2 = \frac{25}{4}$$

$A^2 = B \rightarrow A = \sqrt{B}$ or $A = -\sqrt{B}$

$$x - \frac{3}{2} = \sqrt{\frac{25}{4}} \text{ or } x - \frac{3}{2} = -\sqrt{\frac{25}{4}}$$

evaluate

$$x - \frac{3}{2} = \frac{5}{2} \text{ or } x - \frac{3}{2} = -\frac{5}{2}$$

TYPE OR USE \leftrightarrow = ENTER = OK AND ESC = CANCEL

FIG 3N

F1V	F2V	F3	F4V	F5V	F6V	F7V
Prob	Set	Prob	Trans	Cntrl	?	Tools

P3: Solve for x

$$x - \frac{3}{2} = \sqrt{\frac{25}{4}} \text{ or } x - \frac{3}{2} = -\sqrt{\frac{25}{4}}$$

evaluate

$$x - \frac{3}{2} = \frac{5}{2} \text{ or } x - \frac{3}{2} = -\frac{5}{2}$$

solve linear equation

$$x = 4 \text{ or } x = -1$$

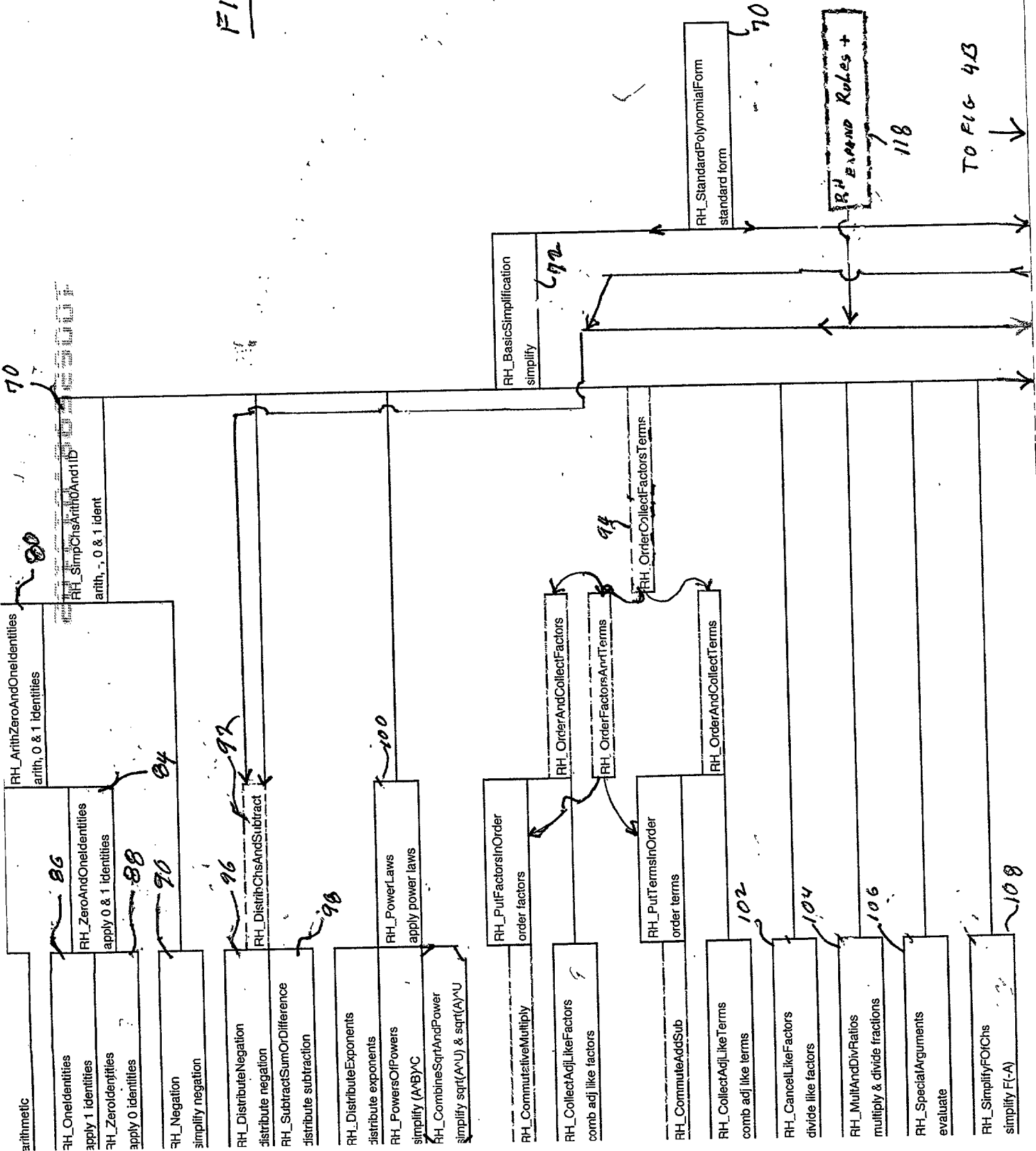
MAIN DEG AUTO FUNC 3/4

FIG 3O

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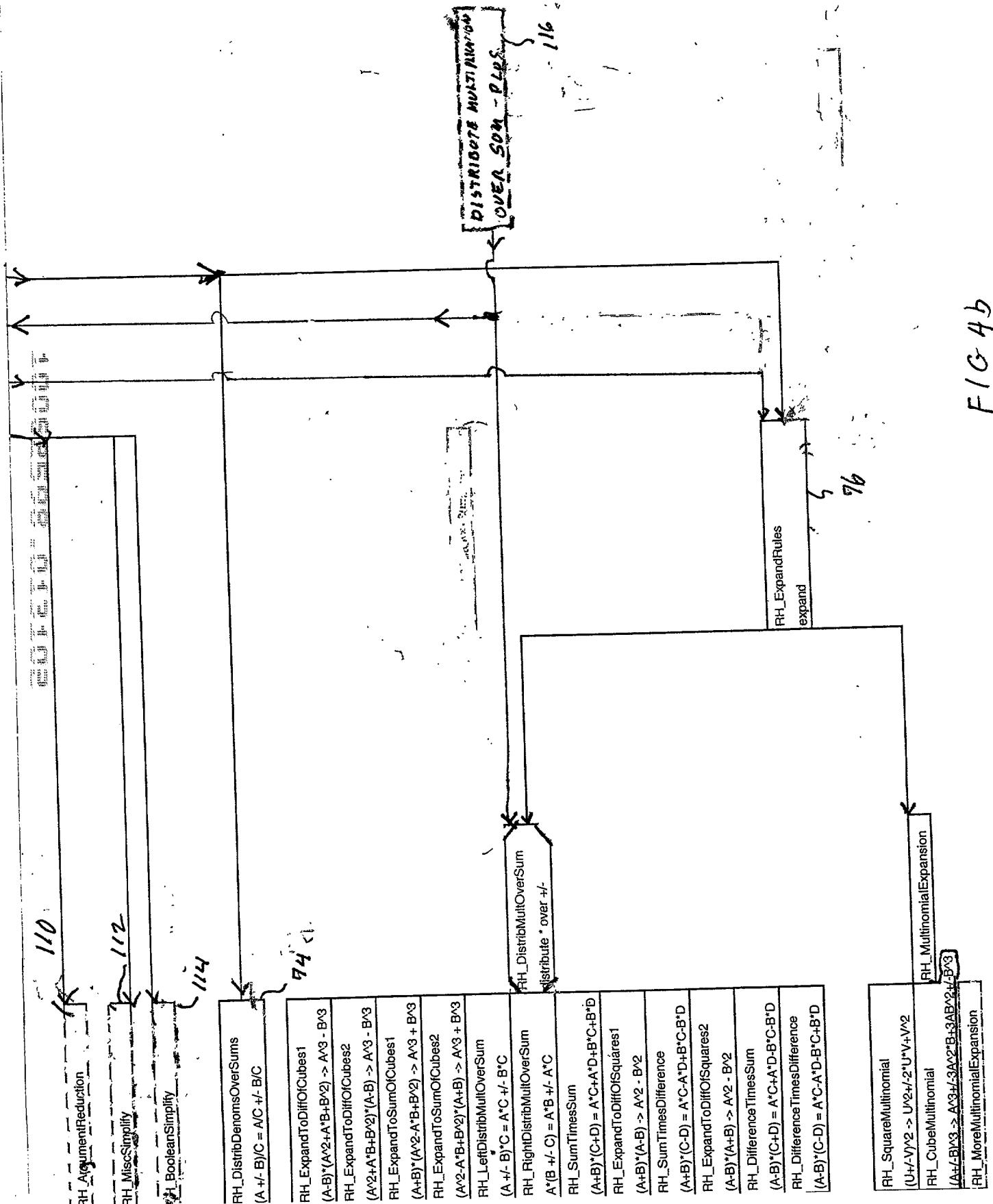
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FIG 4A



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RH_OneTimesAny
$1 \cdot A = A$
RH_AnyTimesOne
$A \cdot 1 = A$
RH_AnyOnOne
$A/1 = A$
RH_AnyUpOne
$A^1 = A$
RH_OneUpAny
$1^A = 1$

RH_OneIdentities
apply 1 identities

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RH_ChSZero
$-0 = 0$
RH_AnyTimesZero
$A \cdot 0 = 0$
RH_ZeroTimesAny
$0 \cdot A = 0$
RH_AnyPlusZero
$A + 0 = A$
RH_ZeroPlusAny
$0 + A = A$
RH_AnyMinusZero
$A - 0 = A$
RH_ZeroMinusAny
$0 - A = -A$
RH_ZeroOnAny
$0/A = 0 \mid A \neq 0$
RH_AnyOnZero
$A/0 = \text{undef}$
RH_AnyUpZero
$A^0 = 1 \mid A \neq 0$
RH_ZeroUpAny
$0^A = 0 \mid A > 0$

RH_ZeroIdentities
apply 0 identities

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FIG 4C

RH_ChSChS
$--A = A$
RH_ChSOneTimesToChS
$-1 \cdot A = -A$
RH_ChSTimesToChSProd
$(-A) \cdot B = -(A \cdot B)$
RH_TimesChSToChSProd
$A \cdot -B = -(A \cdot B)$
RH_AnyPlusChSAny
$A + -B = A - B$
RH_AnyMinusChSAny
$A - -B = A + B$
RH_ChSOnToChSRatio
$(-A)/B = -(A/B)$
RH_OnChSToChSRatio
$A/-B = -(A/B)$
RH_AnyUpMinus1
$A^{-1} \rightarrow 1/A$
RH_AnyUpChSAny
$A^{-B} = 1/A^B$

RH_Negation
simplify negation

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RH_StrictDistribNegOverSum	
"-(A+B) = -A-B"	
RH_DistribNegationOverSum	RH_DistributeNegation
RH_StrictDistribNegOverDiff	distribute negation
"-(A-B) = -A+B"	
RH_DistribNegationOverDiff	

RH_StrictSubtractSum	
A-(B+C) = A-B-C	
RH_StrictSubtractDifference	RH_SubtractSumOrDifference
A-(B-C) = A-B+C	distribute subtraction
RH_SubtractSum	
RH_SubtractDifference	

RH_DistribPowOverProd1	
(A*B)^C -> A^C*B^C	
RH_DistribPowOverProd2	
(A*B)^C -> A ^C* B ^C	
RH_DistribPowOverRatio1	RH_DistributeExponents
(A/B)^C -> A^C/B^C	distribute exponents
RH_DistribPowOverRatio2	
(A/B)^C -> A ^C/ B ^C	
RH_DistribUpEvenOnOddOverChs	
(-A)^B -> A^B	
RH_DistribUpOddOnOddOverChs	
(-A)^B -> -A^B	

RH_MultPowers2to7	
(A^B)^C -> A^(B*C)	
RH_MultPowers1	RH_PowersOfPowers
(A^B)^C -> A ^C(B^C)	simplify (A^B)^C

RH_SqrtOfSquare	
sqrt(A^2) -> A	
RH_SqrtPower1	RH_SqrtPower
sqrt(A^(2*N)) -> A ^N	simplify sqrt(A^U)
RH_SqrtPower2	
sqrt(A^(2N+1)) -> A^N*sqrt(A)	
	RH_CombineSqrtAndPower
	simplify sqrt(A^U) & sqrt(A)^U
RH_SquareOfSqrt	
sqrt(A)^2 -> A A >= 0	
RH_EvenPowerOfSqrt	RH_PowerSqrt
sqrt(A)^(2N) -> A^N A >= 0	simplify sqrt(A)^U
RH_OddPowerOfSqrt	
sqrt(A)^(2N+1) -> A^N*sqrt(A)	

FIG 4d

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RH_CombineAdjIdenticalSqrts
$\sqrt{A} \cdot \sqrt{A} \rightarrow A \mid A \neq 0$
RH_CollectAdjLikePowers
$A^U \cdot A^V \rightarrow A^{(U+V)}$
RH_CollectAdjLikePowerAndBase
$A^U \cdot A \rightarrow A^{(U+1)}$
RH_CollectAdjLikeBaseAndPower
$A \cdot A^U \rightarrow A^{(1+U)}$
RH_CollectAdjLikeNonPowers
$A \cdot A \rightarrow A^2$

RH_CollectAdjLikeFactors
comb adj like factors

RH_FracTimesFrac
$(A/B) \cdot (C/D) \rightarrow (A \cdot C) / (B \cdot D)$
RH_AnyTimesFrac
$A \cdot (B/C) \rightarrow (A \cdot B) / C$
RH_FracTimesAny
$(A/C) \cdot B \rightarrow (A \cdot B) / C$

RH_MultiplyFractions
multiply fractions

RH_MultAndDivRatios
multiply & divide fractions

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RH_FractionOnFraction
$(A/B) / (C/D) \rightarrow (A \cdot D) / (B \cdot C)$
RH_FractionOnAny
$(A/B) / C \rightarrow A / (B \cdot C)$
RH_OneOnFraction
$1 / (A/B) \rightarrow B / A \mid B \neq 0$
RH_AnyOnFraction
$A / (C/B) \rightarrow (A \cdot B) / C$

RH_DivideFractions
divide fractions

RH_CancelInverseFunctions
cancel inverse functions
RH_CombineRelatedInverseFunc
RH_LnSpecialArguments
evaluate logarithms
RH_SqrtSpecialArguments
evaluate sqrt
RH_EvalFractPow
evaluate fract powers
RH_AbsApplyDef
evaluate abs
RH_SignApplyDef
evaluate sign
RH_SinSpecialArguments
evaluate sin
RH_CosSpecialArguments
evaluate cos
RH_TanSpecialArguments
evaluate tan
RH_AsinSpecialArguments
evaluate asin
RH_AcosSpecialArguments
evaluate acos
RH_AtanSpecialArguments
evaluate atan

RH_SpecialArguments
evaluate

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FIG 4e

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RH_Lne
$\ln(e) = 1$
RH_LnOfExp
$\ln(e^A) = A$
RH_eUpLn
$e^{\ln(A)} \rightarrow A \mid A > 0$
RH_LogOf10
$\log(10) = 1$
RH_LogOf10toThe
$\log(10^A) = A$
RH_10UpLog
$10^{\log(A)} \rightarrow A \mid A > 0$
RH_SinAsin
$\sin(\sin(A)) \rightarrow A$
RH_AsinSin
$\sin(\sin(A)) \rightarrow A$
RH_CosAcos
$\cos(\cos(A)) \rightarrow A$
RH_AcosCos
$\cos(\cos(A)) \rightarrow A$
RH_TanAtan
$\tan(\tan(A)) \rightarrow A$
RH_AtanTan
$\tan(\tan(A)) \rightarrow A$

RH_CancelInverseFunctions
cancel inverse functions

RH_SinAcos
$\sin(\cos(A)) \rightarrow \sqrt{1-A^2}$
RH_SinAtan
$\sin(\tan(A)) \rightarrow A/\sqrt{A^2+1}$
RH_CosAsin
$\cos(\sin(A)) \rightarrow \sqrt{1-A^2}$
RH_CosAtan
$\cos(\tan(A)) \rightarrow 1/\sqrt{A^2+1}$
RH_TanAsin
$\tan(\sin(A)) \rightarrow A/\sqrt{1-A^2}$
RH_TanAcos
$\tan(\cos(A)) \rightarrow \sqrt{1-A^2}/A$

RH_CombineRelatedInverseFunc

FIG 4f

RH_LnOne
$\ln(1) = 0$
RH_LnNonpositive
$\ln(\text{nonpositive}) = \text{undef}$
RH_LogOne
$\log(1) = 0$
RH_LogNonpositive
$\log(\text{nonpositive}) = \text{undef}$

RH_LnSpecialArguments
evaluate logarithms

RH_SqrtNum
RH_Sqrt0
$\sqrt{0} \rightarrow 0$
RH_Sqrt1
$\sqrt{1} \rightarrow 1$
RH_SqrtNegative
$\sqrt{\text{negative}} = \text{undef}$

RH_SqrtSpecialArguments
evaluate sqrt

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RH_AbsNonnegative	
$ A \mid A \geq 0 \rightarrow A$	
RH_AbsNonpositive	RH_AbsApplyDef
$ A \mid A \leq 0 \rightarrow -A$	evaluate abs
RH_AbsSign	
$ \text{sign}(A) \rightarrow 1$	

RH_Sin0	
$\sin(0) \rightarrow 0$	
RH_SinPiOn6	
$\sin(\pi/6) \rightarrow 1/2$	
RH_SinPiOn4	
$\sin(\pi/4) \rightarrow \sqrt{2}/2$	
RH_SinPiOn3	RH_SinSpecialArguments
$\sin(\pi/3) \rightarrow \sqrt{3}/2$	evaluate sin
RH_SinPiOn2	
$\sin(\pi/2) \rightarrow 1$	
RH_SinPi	
$\sin(\pi) \rightarrow 0$	
RH_SinNPi	
$\sin(N\pi) \rightarrow 0$	
RH_SinNPlusHalfPi	
$\sin((N+1/2)\pi) \rightarrow (-1)^N$	

RH_Cos0	
$\cos(0) \rightarrow 1$	
RH_CosPiOn6	
$\cos(\pi/6) \rightarrow \sqrt{3}/2$	
RH_CosPiOn4	
$\cos(\pi/4) \rightarrow \sqrt{2}/2$	
RH_CosPiOn3	RH_CosSpecialArguments
$\cos(\pi/3) \rightarrow 1/2$	evaluate cos
RH_CosPiOn2	
$\cos(\pi/2) \rightarrow 0$	
RH_CosPi	
$\cos(\pi) \rightarrow -1$	
RH_CosNPi	
$\cos(N\pi) \rightarrow (-1)^N$	
RH_CosNPlusHalfPi	
$\cos((N+1/2)\pi) \rightarrow 0$	

RH_Tan0	
$\tan(0) \rightarrow 0$	
RH_TanPiOn6	
$\tan(\pi/6) \rightarrow \sqrt{3}/3$	
RH_TanPiOn4	
$\tan(\pi/4) \rightarrow 1$	
RH_TanPiOn3	RH_TanSpecialArguments
$\tan(\pi/3) \rightarrow \sqrt{3}$	evaluate tan
RH_TanPi	
$\tan(\pi) \rightarrow 0$	
RH_TanNPi	
$\tan(N\pi) \rightarrow 0$	
RH_TanNPlusHalfPi	
$\tan((N+1/2)\pi) \rightarrow \text{undef}$	

FIG 4g

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RH_Asin0	
asin(0) -> 0	
RH_Asin1	
asin(1) -> pi/2	
RH_AsinHalf	RH_AsinSpecialArguments
asin(1/2) -> pi/6	evaluate asin
RH_AsinSqrt2On2	
asin(sqrt(2)/2) -> pi/4	
RH_AsinSqrt3On2	
asin(sqrt(3)/2) -> pi/3	

RH_Acos0	
acos(0) -> pi/2	
RH_Acos1	
acos(1) -> 0	
RH_AcosHalf	RH_AcosSpecialArguments
acos(1/2) -> pi/3	evaluate acos
RH_AcosSqrt2On2	
acos(sqrt(2)/2) -> pi/4	
RH_AcosSqrt3On2	
acos(sqrt(3)/2) -> pi/6	

RH_Atan0	
atan(0) -> 0	
RH_Atan1	
atan(1) -> pi/4	
RH_AtanSqrt3On3	RH_AtanSpecialArguments
atan(sqrt(3)/3) -> pi/6	evaluate atan
RH_AtanSqrt3	
atan(sqrt(3)) -> pi/3	

RH_SignChs	
sign(-A) -> -sign(A)	
RH_SinChs	
sin(-A) -> -sin(A)	
RH_AsinChs	RH_FOfChsToChsF
asin(-A) -> -asin(A)	F(-A) -> -F(A)
RH_TanChs	
tan(-A) -> -tan(A)	
RH_AtanChs	
atan(-A) -> -atan(A)	
	RH_SimplifyFOfChs
	simplify F(-A)
RH_AbsChs	
abs(-A) -> abs(A)	
RH_CosChs	RH_FOfChsToF
cos(-A) -> cos(A)	F(-A) -> F(A)
RH_AcosChs	
acos(-A) -> pi - cos(A)	

FIG 44

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RH_SinAPlusOrMinusPi	
$\sin(A[+/-]\pi) \rightarrow -\sin(A)$	
RH_SinAPlusPiOn2	
$\sin(A+\pi/2) \rightarrow \cos(A)$	
RH_SinAMinusPiOn2	
$\sin(A-\pi/2) \rightarrow -\cos(A)$	
RH_SinAPlusOrMinus2nPi	
$\sin(A[+/-]2N\pi) \rightarrow \sin(A)$	
RH_CosAPlusOrMinusPi	
$\cos(A[+/-]\pi) \rightarrow -\cos(A)$	
RH_CosPiOn2MinusA	RH_ArgumentReduction
$\cos(\pi/2-A) \rightarrow \sin(A)$	
RH_CosAPlusPiOn2	
$\cos(A+\pi/2) \rightarrow -\sin(A)$	
RH_CosAPlusOrMinus2nPi	
$\cos(A[+/-]2N\pi) \rightarrow \cos(A)$	
RH_TanAPlusOrMinusPi	
$\tan(A[+/-]\pi) \rightarrow \tan(A)$	
RH_TanAPlusOrMinusPiOn2	
$\tan(A[+/-]\pi/2) \rightarrow -(1/\tan(A))$	
RH_TanAPlusOrMinusNPi	
$\tan(A[+/-]N\pi) \rightarrow \tan(A)$	

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RH_EvenNumrPowerOfAbs	
$ A ^U \rightarrow A^U$	
RH_EvenNumrPowerOfSign	
$(\text{sign}(A))^U \rightarrow 1$	
RH_SignOfPower	RH_MiscSimplify
$\text{simplify}(\text{sign}(A^U))$	
RH_NegUpOddOnEven	
$\text{neg}^{\text{odd/even}} \rightarrow \text{undef}$	

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FIG 4i

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FIG 4j.

to FIG 4k

← to FIG 4N

RH_AddAnaSub: OS

RH_CommuteSum	$A+B \rightarrow B+A$
RH_CommuteProd	$A*B \rightarrow B*A$
RH_CombineLikeFactors	combine like factors
RH_CombineLikeTerms	combine like terms
RH_GroupSimFactors	group factors
RH_CancelGroupedLikeFactors	
RH_ExpCompleteSquare	complete the square
RH_AddSubFracs	
RH_EqualizeDenoms	find common denominator
RH_CommonDenom	add fractions
RH_SimplifyNum	simplify numerator
RH_SimplifyDen	simplify denominator
RH_ExpandNum	expand numerator
RH_ExpandDen	expand denominator
RH_RationalizeNum	rationalize numerator
RH_RationalizeDen	rationalize denominator
RH_Convert1OnAnyToNegExpon	$1/A \rightarrow A^{-1}$
RH_ConvertDenomToNegExpon	$A/B \rightarrow A*B^{-1}$
RH_RatioToProduct1	$A/B \rightarrow (1/B)*A$
RH_RatioToProduct2	$A*B/C \rightarrow (A/C)*B$
RH_RatioToProduct3	$A*B/(C*D) \rightarrow (A/C)*(B/D)$
RH_NumUpRatToNumUpRootUpInt	$A*(M/N) \rightarrow (A^M*(1/N))^M$
RH_NumUpRatToNumUpIntUpRoot	$A*(M/N) \rightarrow (A^M)^{1/N}$
RH_IterateIntPowerGT1	$B^A = B^B * B^{A-B}$ (in times)
RH_Factor	

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FIG 4k

↑
TO FIG 44

TO FIG 48
↓

RH_AdditionalTrms

RH_SortProductByDegree
group factors by degree
RH_DistribBaseOverExponentSum
$A^U \cdot V \rightarrow A^U \cdot A^V$
RH_DistribBaseOverExponentDiffnc
$A^U \cdot V \rightarrow A^U / A^V$
RH_CombinePowers
combine powers
RH_DistributeAbs
distribute abs
RH_CollectAbs
collect abs
RH_PermuteAbsFactorsDeepest
group abs() factors
RH_DistributeSign
distribute sign
RH_SqrtToHalfPow
$\text{sqrt}(A) = A^{(1/2)}$
RH_HalfPowToSqrt
$A^{(1/2)} = \text{sqrt}(A)$
RH_DistributeSqrt
distribute sqrt
RH_CombineSqrts
RH_PermuteSqrtFactorsDeepest
group sqrt() factors
RH_LnExpand
expand logarithms
RH_PermuteLnTermsDeepest
group ln() terms
RH_PermuteLogTermsDeepest
group log() terms
RH_LnCollect
collect logarithms
RH_LnToLog
convert ln to log
RH_LogToLn
convert log to ln
RH_TrigExpand
trigonometric expansion
RH_ExpandHalfAngles
expand half angles
RH_TanToSinOnCos
$\tan(A) \rightarrow \sin(A)/\cos(A)$
RH_SinAToCosPiOn2MinusA
$\sin(A) \rightarrow \cos(\pi/2 - A)$
RH_CosToSinPiOn2MinusA
$\cos(A) \rightarrow \sin(\pi/2 - A)$

TO FIG 40

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FIG 42

TO FIG 42

TO FIG 43

RH_SinSqToMinusCosSq
RH_CosSqTo1MinusSinSq
RH_AsinToAcos
asin(A) -> pi/2 - acos(A)
RH_AcosToAsin
acos(A) -> pi/2 - asin(A)
RH_AsinToAtan
asin(S) -> atan(S/sqrt(1-S^2))
RH_AtanToAsin
atan(T) -> asin(T/sqrt(T^2+1))
RH_AtanReciprocalToAtanNon
atan(1/A) -> pi/2*sign(A) - atan(A)
RH_ChsProd
-(A*B) -> (-A)*B
RH_MinusToPlusChs
A*B -> A+(-B)
RH_AupBtoEupBlnA
A^U -> e^(U*ln(A))
RH_AupBto10upBlogA
A^U -> 10^(U*log(A))
RH_UpProdToUpUp
A^U * V -> (A^U)^V
RH_AupBupCToAupCupB
(A^U)^V^W -> 16 (A^U)^V^W

TO FIG 42

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RH_CancelAonA
$A/A \rightarrow 1 \mid A \neq 0$
RH_PowerOnLikeBaseToPower
$A^U/A \rightarrow A^{(U-1)}$
RH_BaseOnLikePowerToPower
$A/A^U \rightarrow A^{(1-U)}$
RH_PowerOnLikePowerToPower
$A^U/A^V \rightarrow A^{(U-V)}$
RH_PowerOnLikeBaseToRecip
$A^U/A \rightarrow 1/A^{(1-U)}$
RH_BaseOnLikePowerToRecip
$A/A^U \rightarrow 1/A^{(U-1)}$
RH_PowerOnLikePowerToRecip
$A^U/A^V \rightarrow 1/A^{(V-U)}$

RH_CancelGroupedLikeFactors

(see FIG 4j)

RH_AddSubFrac1
$A/C \pm B/C \rightarrow (A \pm B)/C$
RH_AddSubFrac2
$A/B \pm C/D \rightarrow (D \cdot A \pm B \cdot C)/(B \cdot D)$
RH_AddSubFrac3
$A/D \pm B \rightarrow (A \pm D \cdot B)/D$
RH_AddSubFrac4
$A \pm B/D \rightarrow (D \cdot A \pm B)/D$

RH_AddSubFrac

(see FIG 4j)

Fig 4m

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RH_StrictFactorChsAnyMinusAny	
$-A-B \rightarrow -(A+B)$	
RH_FactorChsAnyMinusAny	RH_FactorNegation
RH_StrictFactorChsAnyPlusAny	factor - from +/-
$-A+B \rightarrow -(A-B)$	
RH_FactorChsAnyPlusAny	
RH_FctrOutCommonDivisorOfTerms	
factor out ?	
RH_FactorPerfectSquare	
$A^2 \pm 2AB + B^2 \rightarrow (A \pm B)^2$	
RH_FactorDiffOfSquares	
$A^2 - B^2 \rightarrow (A+B)(A-B)$	
RH_FactorDiffOfCubes	
$A^3 - B^3 \rightarrow (A-B)(A^2 + AB + B^2)$	
RH_FactorSumOfCubes	
$A^3 + B^3 \rightarrow (A+B)(A^2 - AB + B^2)$	
RH_FactorSumOrDiff	
factor	
RH_FactorInteger	
factor integer	
RH_FactorNumerator	
factor numerator	
RH_FactorDenominator	
factor denominator	
RH_FactorLeft1	
$A[+-]A*B \rightarrow A * (1[+-]B)$	
RH_FactorLeft2	
$A[+-]A*B \rightarrow A * (-1[+-]B)$	
RH_FactorLeft3	
$A[+-]A*B \rightarrow A * (1[+-]B)$	
RH_FactorLeft4	
$A*B[+-]A \rightarrow A * (B[+-]1)$	
RH_FactorLeft5	
$A*B[+-]A \rightarrow A * (-B[+-]1)$	
RH_FactorLeft6	
$A*B[+-]A \rightarrow A * (B[+-]1)$	
RH_FactorLeft7	
$A*B[+-]A*C \rightarrow A * (B[+-]C)$	
RH_FactorLeft8	
$-A*B[+-]A*C \rightarrow A * (-B[+-]C)$	
RH_FactorLeft9	
$A*B[+-]A*C \rightarrow A * (B[+-]C)$	
RH_FactorRight1	
$B[+-]A*B \rightarrow (1[+-]A)*B$	
RH_FactorRight2	
$-B[+-]A*B \rightarrow (-1[+-]A)*B$	
RH_FactorRight3	
$A*B[+-]B \rightarrow (A[+-]1)*B$	
RH_FactorRight4	
$A*B[+-]B \rightarrow (A[+-]1)*B$	
RH_FactorRight5	
$A*C[+-]B*C \rightarrow (A[+-]B)*C$	

RH_Factor

(See FIG 4A)

FIG 4N

RH_CombineProductsOfPowers
$A^C \cdot B^A \rightarrow (A \cdot B)^A \cdot C$
RH_CombineRatiosOfPowers
$A^C / B^A \rightarrow (A/B)^A \cdot C$

RH_CombinePowers
combine powers

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RH_AbsProduct
$ A \cdot B \rightarrow A \cdot B $
RH_AbsRatio
$ A/B \rightarrow A / B $
RH_AbsOfUpEitherOnOdd
$ A^B \rightarrow A ^B$

RH_DistributeAbs
distribute abs

RH_SignProduct
$\text{sign}(A \cdot B) \rightarrow \text{sign}(A) \cdot \text{sign}(B)$
RH_SignRatio
$\text{sign}(A/B) \rightarrow \text{sign}(A)/\text{sign}(B)$

RH_DistributeSign
distribute sign

RH_DistribSqrtOverProd
$\sqrt{A \cdot B} \rightarrow \sqrt{A} \cdot \sqrt{B}$
RH_DistribSqrtOverRatio
$\sqrt{A/B} \rightarrow \sqrt{A}/\sqrt{B}$

RH_DistributeSqrt
distribute sqrt

RH_CombineProdSqrts
$\sqrt{A} \cdot \sqrt{B} \rightarrow \sqrt{A \cdot B}$
RH_CombineRatioSqrts
$\sqrt{A}/\sqrt{B} \rightarrow \sqrt{A/B}$

RH_CombineSqrts

(see FIG 4b)

RH_LnProduct
$\ln(U \cdot V) \rightarrow \ln(U) + \ln(V)$
RH_LnRatioOneOnAny
$\ln(1/A) \rightarrow -\ln(A)$
RH_LnRatio
$\ln(U/V) \rightarrow \ln(U) - \ln(V)$
RH_LnPow
$\ln(A^B) \rightarrow B \cdot \ln(A)$
RH_LogProduct
$\log(U \cdot V) \rightarrow \log(U) + \log(V)$
RH_LogRatioOneOnAny
$\log(1/A) \rightarrow -\log(A)$
RH_LogRatio
$\log(U/V) \rightarrow \log(U) - \log(V)$
RH_LogPow
$\log(A^B) \rightarrow B \cdot \log(A)$

RH_LnExpand
expand logarithms

FIG 4a

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RH_ChslLn
$-\ln(A) \rightarrow \ln(1/A)$
RH_ChslLog
$-\log(A) \rightarrow \log(1/A)$
RH_AddLns
$\ln(A)+\ln(B) \rightarrow \ln(A*B)$
RH_AddLogs
$\log(A)+\log(B) \rightarrow \log(A*B)$
RH_SubtractLns
$\ln(A)-\ln(B) \rightarrow \ln(A/B)$
RH_SubtractLogs
$\log(A)-\log(B) \rightarrow \log(A/B)$
RH_AbsorbLnCoef
$A*\ln(B) \rightarrow \ln(B^A)$
RH_AbsorbLogCoef
$A*\log(B) \rightarrow \log(B^A)$

RH_LnCollect
collect logarithms

RH_SinDoubleAngle
$\sin(2*A) \rightarrow 2*\sin(A)*\cos(A)$
RH_CosDoubleAngle
$\cos(2*A) \rightarrow \cos(A)^2 - \sin(A)^2$
RH_TanDoubleAngle
$\tan(2*A) \rightarrow 2*\tan(A)/(1-\tan(A)^2)$

RH_ExpandDoubleAngles
expand double angles

RH_SinAngleSumOrDifference
expand $\sin(A \pm B)$
RH_CosAngleSum
expand $\cos(A+B)$
RH_CosAngleDifference
expand $\cos(A-B)$
RH_TanAngleSum
expand $\tan(A+B)$
RH_TanAngleDifference
expand $\tan(A-B)$

RH_TrigExpand
trigonometric expansion

RH_ExpandAngleSumsOrDifferences

RH_SinHalfAngleNonnegative
$\sin(A/2) \rightarrow \sqrt{(1-\cos(A))/2}$
RH_SinHalfAngleNonpositive
$\sin(A/2) \rightarrow -\sqrt{(1-\cos(A))/2}$
RH_CosHalfAngleNonnegative
$\cos(A/2) \rightarrow \sqrt{(\cos(A)+1)/2}$
RH_CosHalfAngleNonpositive
$\cos(A/2) \rightarrow -\sqrt{(\cos(A)+1)/2}$
RH_TanHalfAngle
$\tan(A/2) \rightarrow \sin(A)/(\cos(A)+1)$

RH_ExpandHalfAngles
expand half angles

RH_SinSqTo1MinusCosSq1
$\sin(A)^2 \rightarrow 1 - \cos(A)^2$
RH_SinSqTo1MinusCosSq2
$\sin(A)^3 \rightarrow (1-\cos(A)^2)*\sin(A)$
RH_SinSqTo1MinusCosSq3
$\sin(A)^{(2N)} \rightarrow (1-\cos(A)^2)^N$
RH_SinSqTo1MinusCosSq4
$\sin(A)^{(2N+1)} \rightarrow (1-\cos(A)^2)^N*\sin(A)$

RH_SinSqTo1MinusCosSq

(See Fig 4b)

Fig 4a

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RH_CosSqTo1MinusSinSq1
$\cos(A)^2 \rightarrow 1 - \sin(A)^2$
RH_CosSqTo1MinusSinSq2
$\cos(A)^3 \rightarrow (1 - \sin(A)^2) \cdot \cos(A)$
RH_CosSqTo1MinusSinSq3
$\cos(A)^{2N} \rightarrow (1 - \sin(A)^2)^N$
RH_CosSqTo1MinusSinSq4
$\cos(A)^{2N+1} \rightarrow (1 - \sin(A)^2)^N \cdot \cos(A)$

PH_CosSqTo1MinusSinSq

FIG 4B

cross multiply

$\exists H_SqrtEqualSqrt$
$qnt(A)=sqrt(B) \rightarrow A=B$
$\exists H_EqnCvtEqInNegExpntsToPos$
$\exists (U)=B \wedge (-U) \rightarrow A \wedge U=B \wedge U$
$\exists H_EqnEqualPosExpnts1$
$\exists U=B \wedge U \rightarrow A=B$
$\exists H_EqnEqualPosExpnts2$
$\exists U=B \wedge U \rightarrow A=B$ or $A=-B$
$\exists H_SquareBothSides$
square each side
$\exists H_RaiseBothSidesTo$
raise each side to ?

$\exists H_Ln1To1Property$
$\ln(A)=\ln(B) \rightarrow A=B$
$\exists H_Log1To1Property$
$\log(A)=\log(B) \rightarrow A=B$
$\exists H_EquateExponentsTheorem$
$\exists U=A \wedge v \rightarrow u=v$
$\exists H_LnOfEachSide$
apply ln to each side
$\exists H_LnToExpForm$
$\ln(u)=v \rightarrow e^{\ln u}=e^v$
$\exists H_LogToExpForm$
$\log(u)=v \rightarrow 10^{\log u}=10^v$
$\exists H_ExpToLnForm$
$u=e^v \rightarrow \ln(u)=v$
$\exists H_ExpToLogForm$
$u=10^v \rightarrow \log(u)=v$
$\exists H_SolveForExpnt$
$A \wedge U=B \wedge 16 U=\ln(B)/\ln(A)$

$\exists H_EqnRadical$
$\exists H_EqnLogExpon$

FIG 45

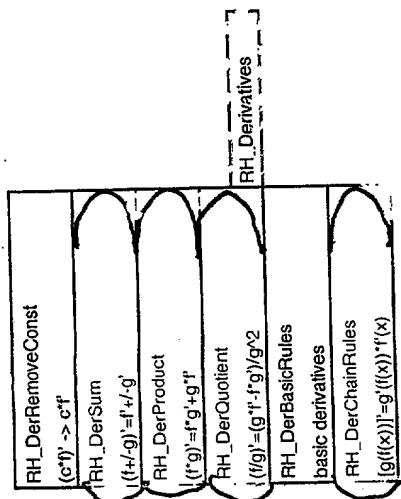
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FIG 40



RED = TOP LEVEL

GREEN = Has Additional Follow Up Rules

APPLICABILITY FLOW DIAGRAM

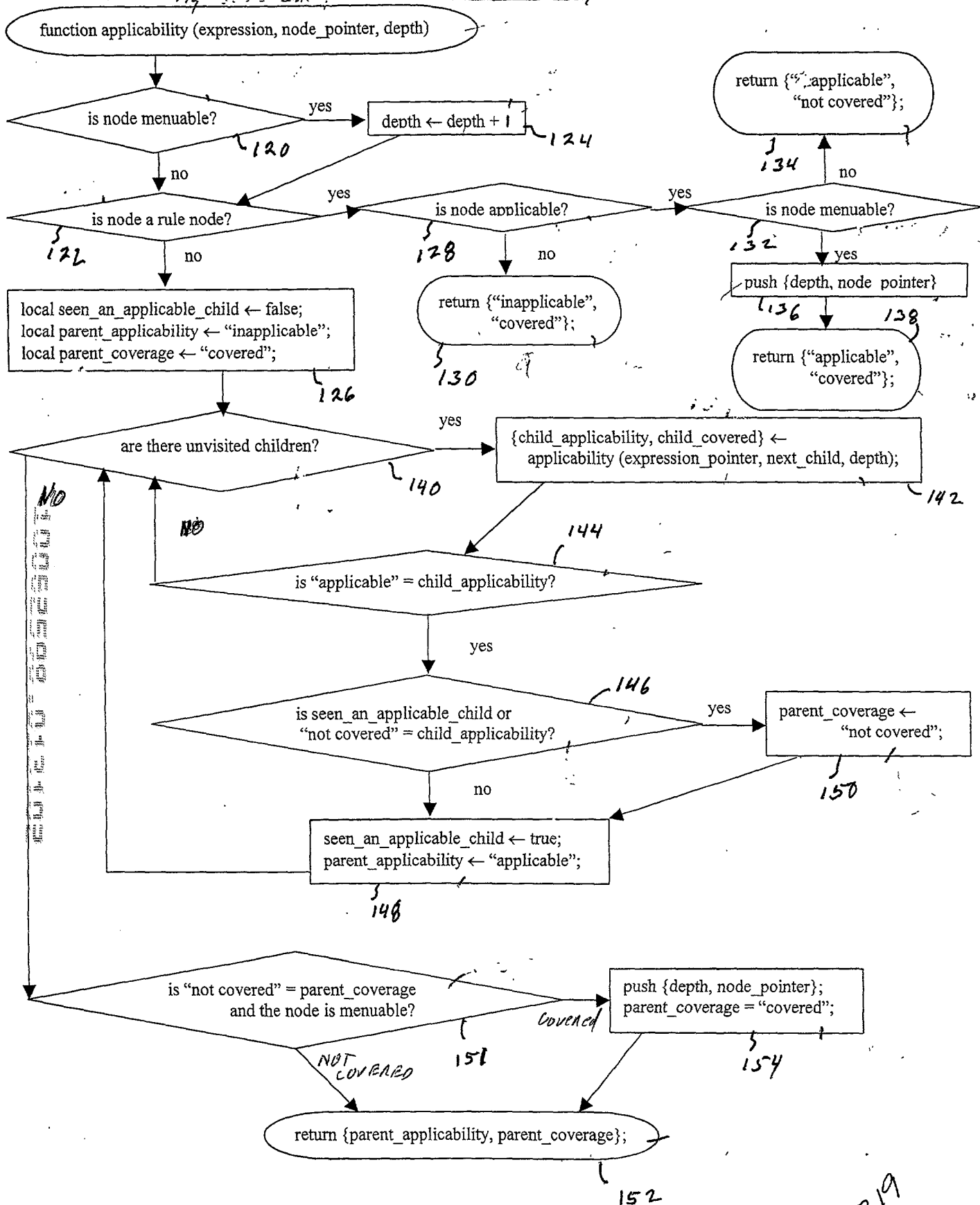


FIG 5

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Pruning Flow Diagram

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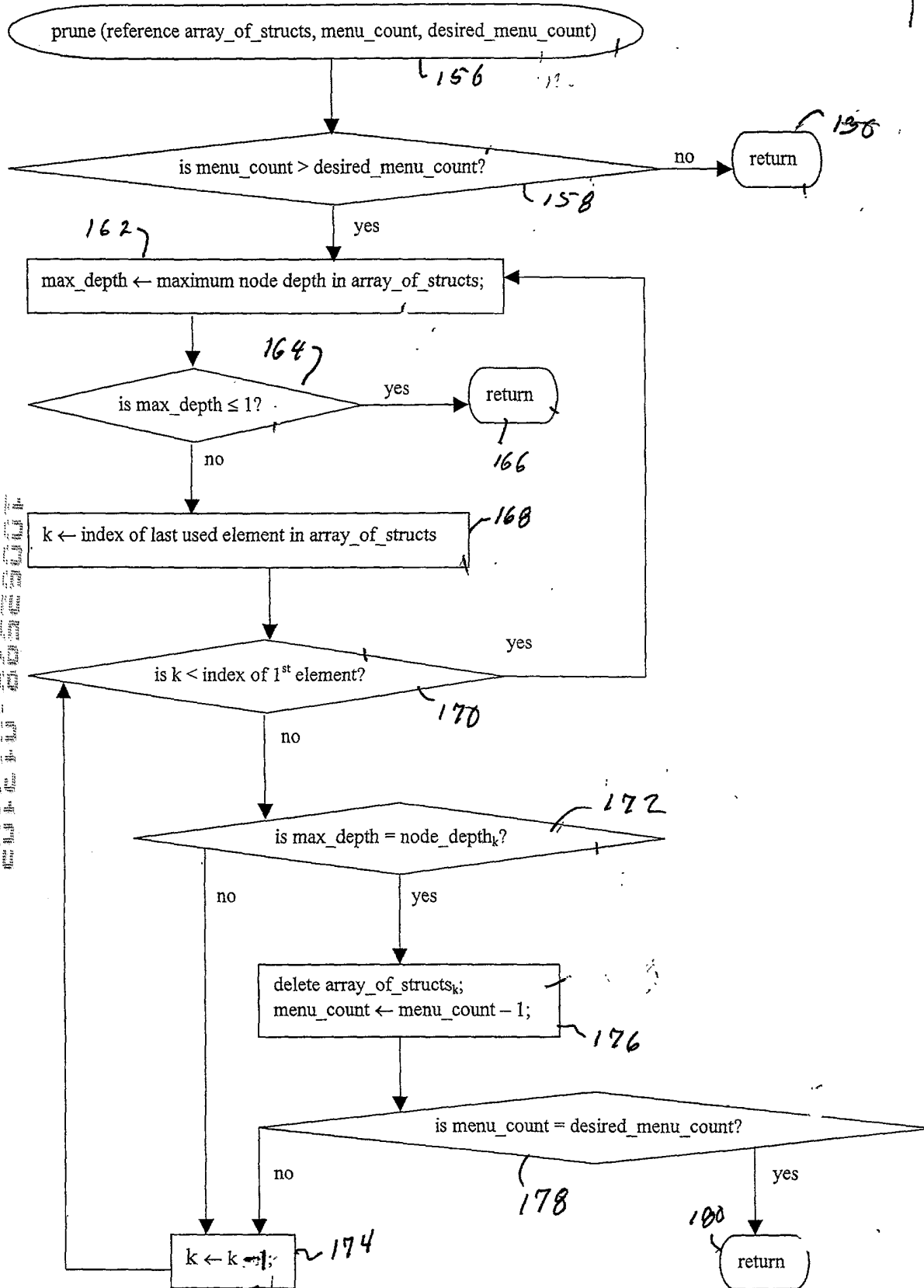


FIG 6

Rule BUCKET

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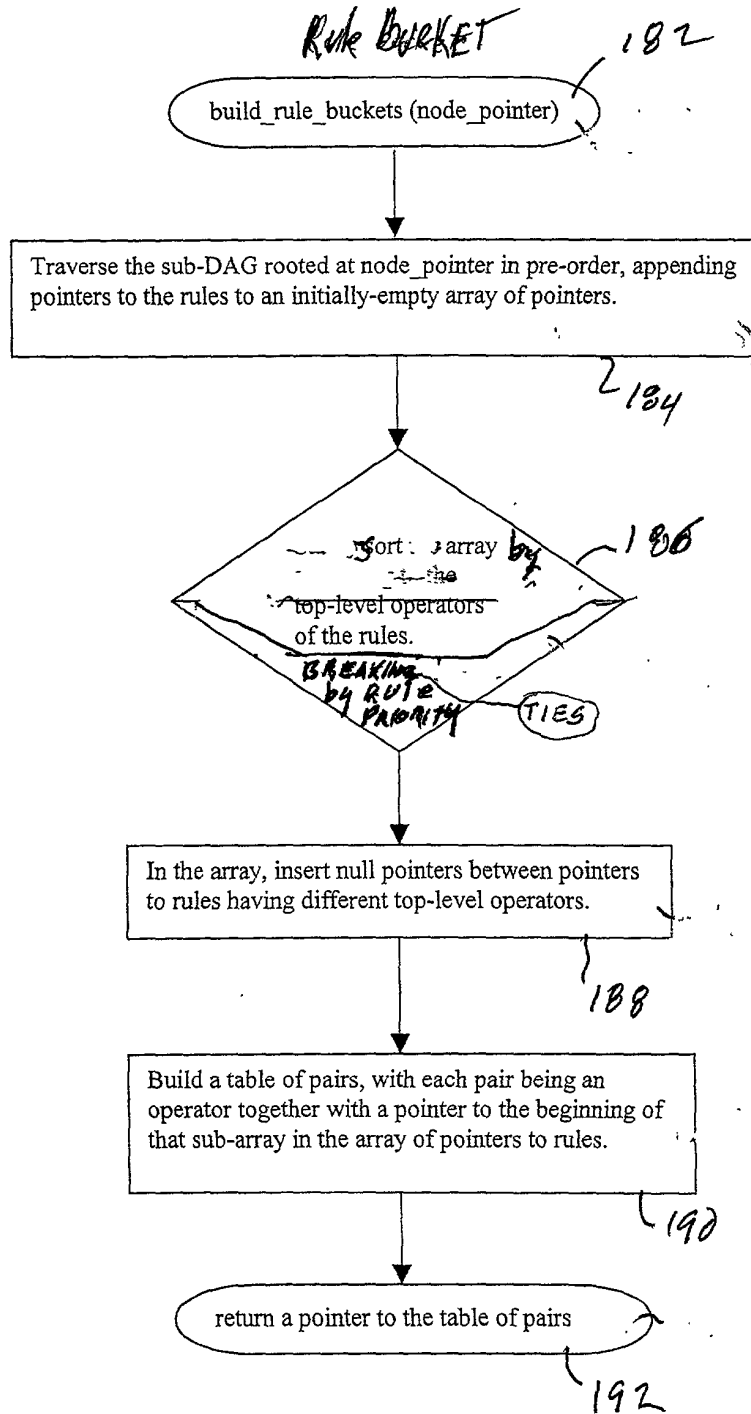


FIG 7

TRANSFORMING EXPRESSIONS

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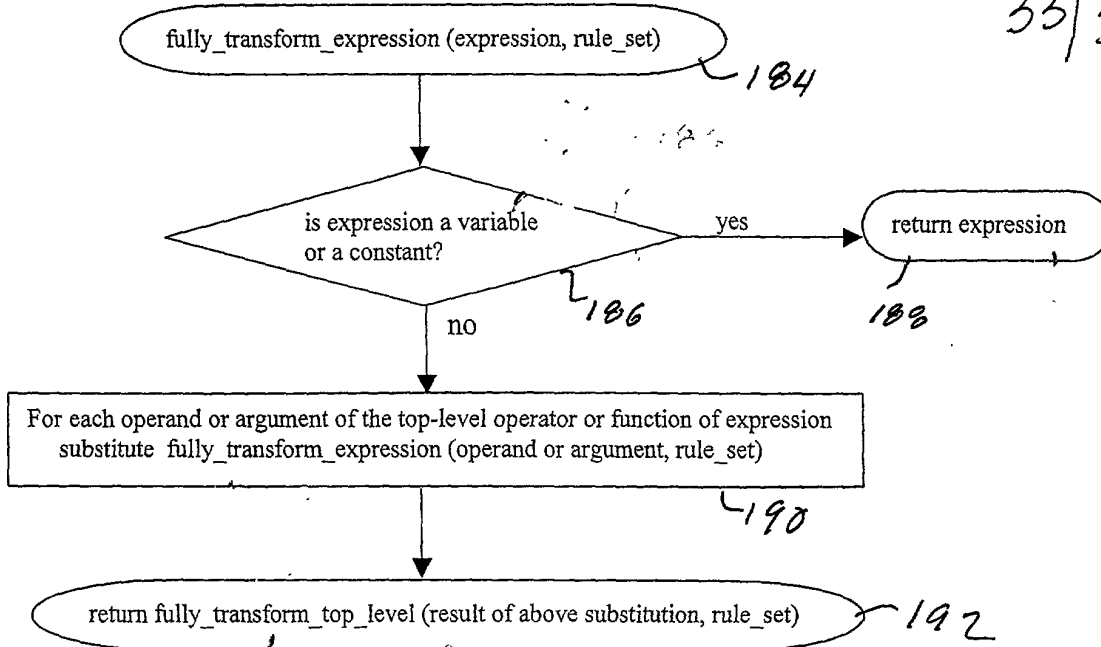


FIG 8A

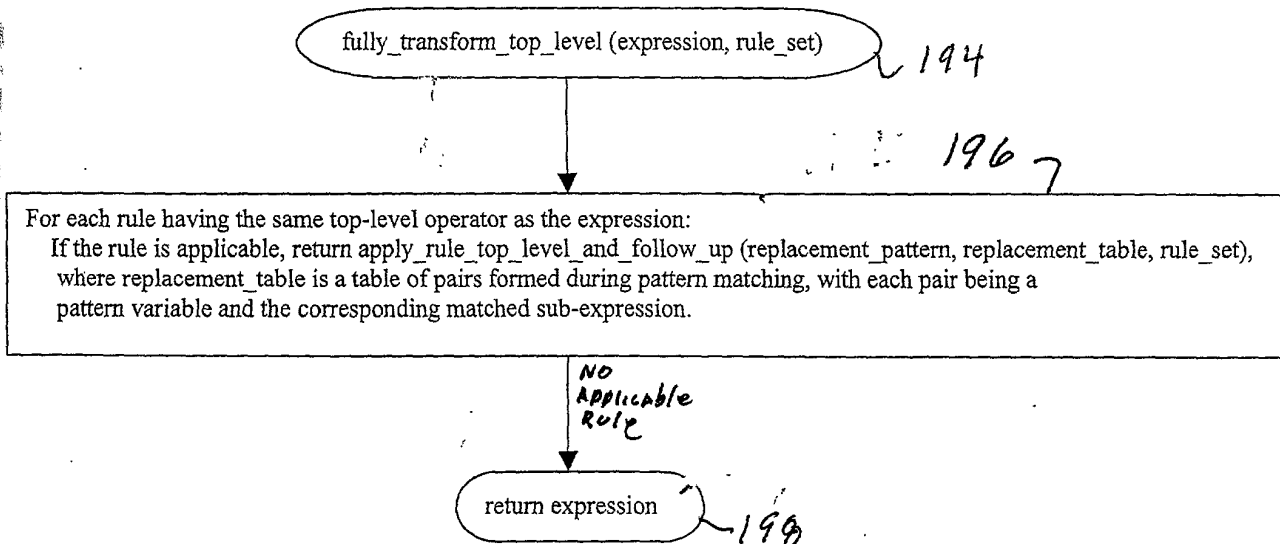


FIG 8B

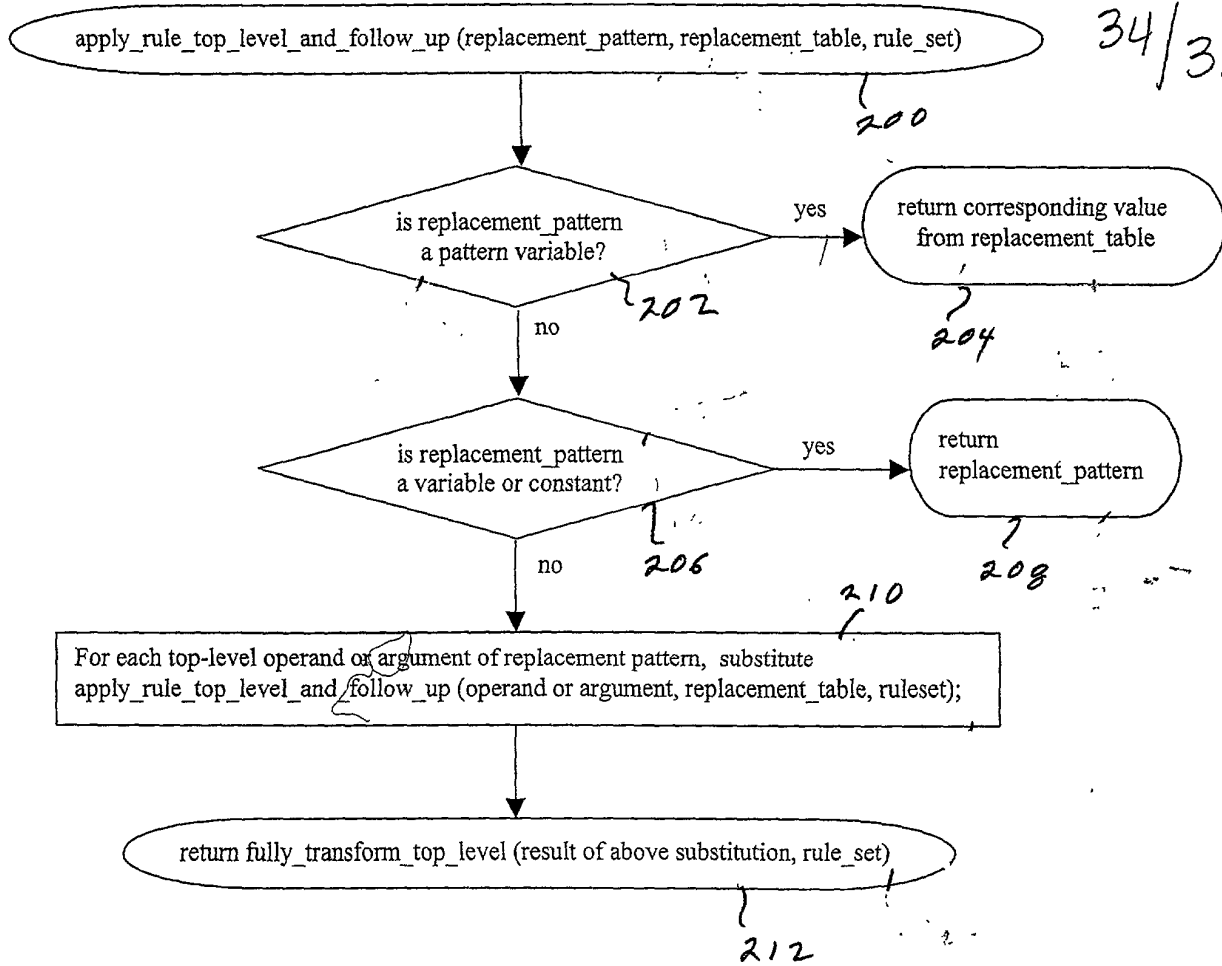


FIG 80

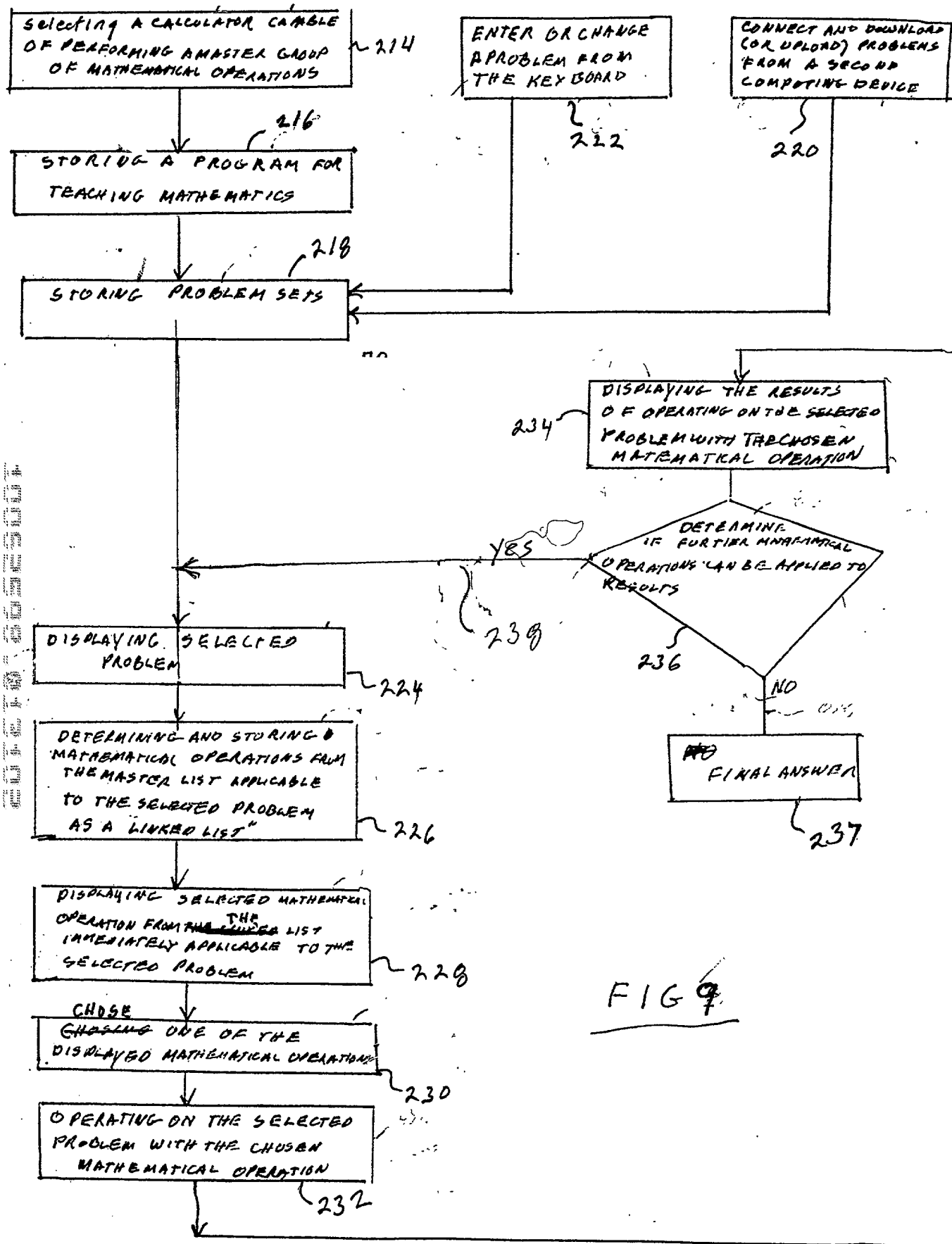


FIG 9